Mass-Manufacturable Wheelchair Controller for People With ALS

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Abstract

The purpose of this project is to create a mass-manufacturable device to support the mobility needs of people with ALS (pALS). The design of this device focuses primarily on interfacing an electric wheelchair with a tablet computer.

Safety peripheral support is included in the device design to augment pALS independence from caregivers. While high performance functionality of the device is at the forefront of our design, regard to manufacturing cost and ease of system integration into existing mobility platforms are the primary factors guiding the design of our final product.

Objective & Requirements

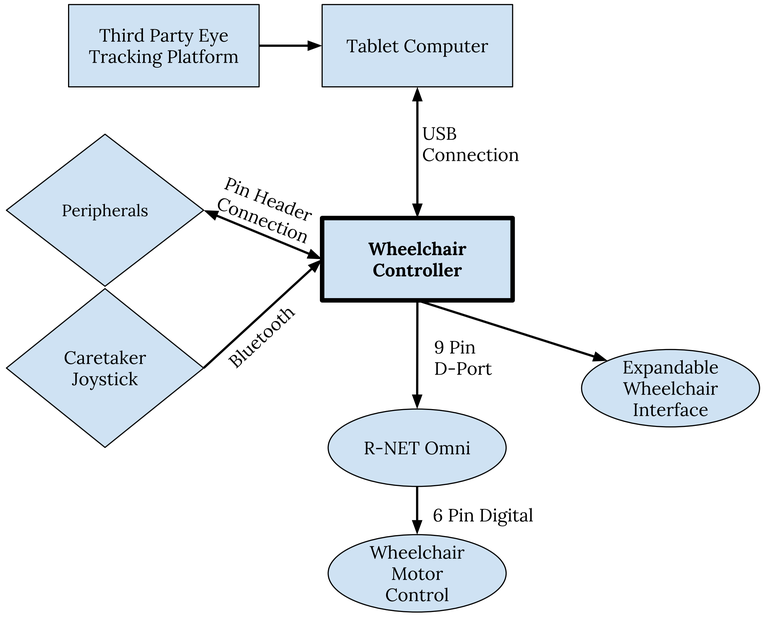
•To produce a device to interface a tablet PC with a wheelchair motor controller and sensor peripherals

•Designed for low power consumption

•Economically accessible

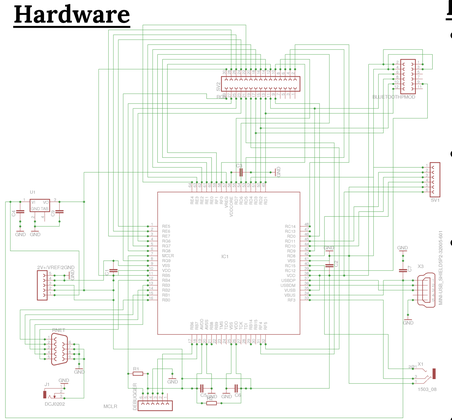
•Expandable for future sensor support

•Wireless caretaker override ability



Design

Hardware



- PIC32MX440F512H Microcontroller
- Design in Eagle CAD
- 2 layer PCB layout
- 5V power provided by USB host and stepped to 3.3V by linear regulator
- Caretaker override device
  - PIC32 Microcontroller
  - Digilent PmodJSTK module
  - PmodBT2 Bluetooth module

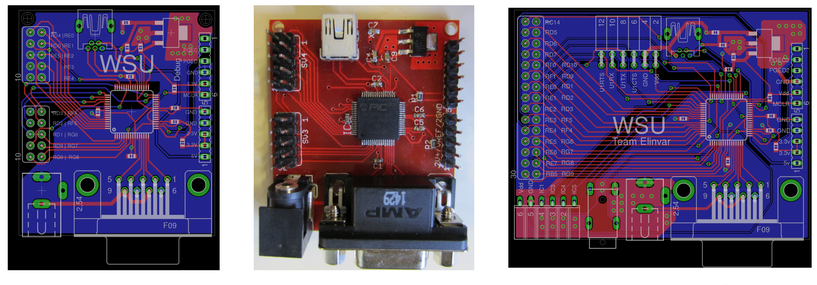
Firmware

- The firmware for the PIC32 microcontroller used in our project was developed using the MPLAB IDE and written in C.
- Our design uses interrupt based actions and a common polling loop.
- Various real-time operating systems are available for our hardware and are an option if more sensors or more complex interfaces are needed in the future.
- Bluetooth modules used between controller device and caregiver override device.

Software

- USB communication from tablet to the microcontroller uses standalone windows driver.
- The standalone windows driver provides a more elegant solution with less overhead.

Revisions & Iterations



Revision 1 Revision 2

- Prototype → Revision 1: Basic communication functions
- Revision 1 → Revision 2: Expanded functionality and communication with specific peripherals

Results & Future Work

Results

- Low-cost wheelchair controller
- Ability to communicate with an array of devices
- Compatible with the majority of electric wheelchair brands by using the proven third party signal controller (R-NET Omni)
- High speed data transfer rates from PC to microcontroller
- Control signals from PC to microcontroller are close to real-time
- Robust and expandable
  - •Direct connections to peripherals
  - •Solid construction
  - •Common grounding

Future Work

- Support for more mobility platforms
- Linux and OSX drivers and API
- Support for additional sensors
- LCD display or 7-segment display for feedback
- Integration into other Team Gleason projects and eye tracking software
- Release driver API to allow third party software to use USB communications through the USB driver

Estimated Unit Production Cost Breakdown[1]

PIC32 Microcontroller	$4.90
Other components	$2.87
PCB Manufacture	$5.86
Assembly[2]	~$2.00
ABS case	$4.25
Total per unit cost	**$19.88**

1: Assuming production run of 2000 units
2: Unquoted rough estimate

Broader Impacts

- Effort towards the global goal of improving quality of life for those persons suffering from ALS and other mobility limiting diseases.
- Minimal manufacturing cost reduces market cost and helps alleviate financial burden of those suffering from ALS.
- Can be used in robotics applications and future research on motorized wheelchairs.
- PCB design focuses on reducing surface area of wheelchair controller to minimize material consumption.

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